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Exploration of growth mechanism for layer controllable graphene on copper

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Graphene, hexagonal network of carbon atoms forming a one-atom thick planar sheet, has been emerged as a fascinating material for future nanoelectronics. Huge attention has been captured by its extraordinary electronic properties, such as bipolar conductance, half integer quantum Hall effect at room temperature, ballistic transport over $\sim 0.4\ \mu$m length and extremely high carrier mobility at room temperature. Several approaches have been developed to produce graphene, such as micro-mechanical cleavage of highly ordered pyrolytic graphite using adhesive tape, chemical reduction of exfoliated graphite oxide, epitaxial growth of graphene on SiC and single crystalline metal substrate, and chemical vapor deposition (CVD) synthesis. In particular, direct synthesis of graphene using metal catalytic substrate in CVD process provides a new way to large-scale production of graphene film for realization of graphene-based electronics. In this method, metal catalytic substrates including Ni and Cu have been used for CVD synthesis of graphene. There are two proposed mechanism of graphene synthesis: carbon diffusion and precipitation for graphene synthesized on Ni, and surface adsorption for graphene synthesized on Cu, namely, self-limiting growth mechanism, which can be divided by difference of carbon solubility of the metals.

Here we present that large area, uniform, and layer controllable graphene synthesized on Cu catalytic substrate is achieved by acetylene-assisted CVD. The number of graphene layer can be simply controlled by adjusting acetylene injection time, verified by Raman spectroscopy. Structural features and full details of mechanism for the growth of layer controllable graphene on Cu were systematically explored by transmission electron microscopy, atomic force microscopy, and secondary ion mass spectroscopy.

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